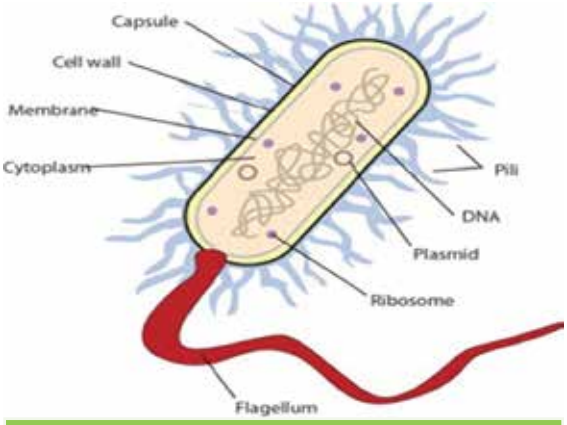
STEMscopedia: PLANT AND ANIMAL CELLS

B.L 14.2 and 14.3

Reflect

Take a moment to think about all of the living things on Earth. There is great diversity among organisms, from microscopic bacteria to massive blue whales—the largest animals on the planet. Despite the tremendous variety of life, all organisms have something in common: they are all made of cells. Some organisms are unicellular, composed of just a single cell; other organisms are multicellular, composed of more than one cell. In fact, the human body is made of about 100 trillion cells!

Although different cells can perform specific functions, all cells can be divided into two large categories. What do you think these categories might be? What are the characteristics of the cells in each category?



In addition to the structures shown, prokaryotic cells contain a central area around the DNA called the *nucleoid*.

Structure and Function of Prokaryotic and Eukaryotic Cells

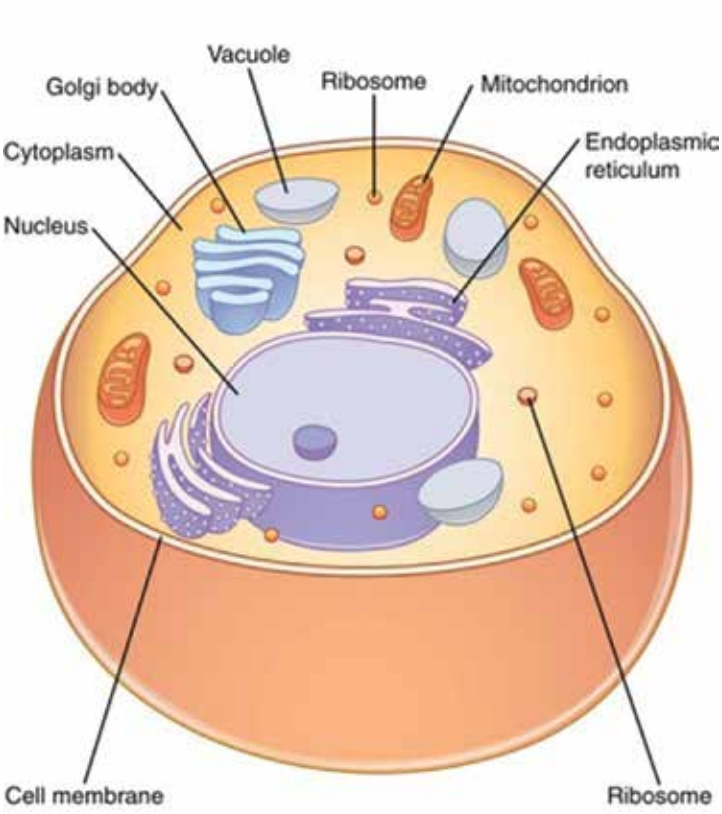
The two categories of cells are prokaryotic cells and eukaryotic cells. A prokaryotic cell is a simple cell that does not contain a nucleus or other membrane-bound organelles. A prokaryotic cell is typically defined by its shape, which may be rodlike, spherical, or spiral. Prokaryotic cells are unicellular organisms, bacteria, and **archaea**. Although they lack membrane-bound organelles, prokaryotic cells have some or all of the structures referenced in the table below. Can you locate each structure in the diagram at the top right of the page?

archaea – single-celled organisms that sometimes live in extremely harsh environments, such as hot springs and salt lakes

Prokaryotic Cell Structures

Structure	Function
Capsule	The capsule is the thin, outermost layer of the cell. Sometimes called “the slime layer,” it provides protection.
Cell wall	The cell wall surrounds the cell and maintains the cell’s shape.
Plasma membrane	Individual membranes do not surround internal structures. However, a single plasma membrane covers the entire cell. The membrane controls materials coming into and going out of the cell.
Cytoplasm	Prokaryotic cells contain a jellylike fluid called *cytoplasm*. Cytoplasm fills most of the space inside the cell.
DNA	DNA within a prokaryotic cell is a single, circular molecule that is not enclosed in a membrane. DNA carries the genetic instructions for the cell.

Nucleoid	Although not enclosed in a nucleus, prokaryotic DNA is generally confined to a central region called the *nucleoid*.
Plasmids	Plasmids are small, circular pieces of DNA found inside prokaryotic cells. Plasmids are not part of the main DNA strand. They are involved in cell activities such as growth and metabolism.
Ribosome	Prokaryotic cells contain ribosomes that help manufacture proteins.
Pili	Hollow, hairlike structures called *pili* surround prokaryotic cells and form channels that enable the cell to attach to other cells and transfer materials.
Flagella	Long, rotating filaments called *flagella* (singular: *flagellum*) help prokaryotic cells move. A cell may have one flagellum, or it may have several flagella.



In contrast to prokaryotic cells, eukaryotic cells are more complex. They contain a nucleus and other membrane-bound organelles that perform specific functions that contribute to the overall **metabolism** and growth of the cell. Eukaryotic cells are found in multicellular organisms, including plants, animals, fungi, and protists. They can also be unicellular protists.

Let's take a closer look at the main structures within a eukaryotic cell. Can you locate each structure in the diagram on the left?

In addition to the structures shown in this animal cell, plant cells contain a cell wall, a central vacuole, and chloroplasts.

metabolism – the process by which cells make, store, and transport chemicals

Eukaryotic Cell Structures

Structure	Function
Cell wall	The cell wall surrounds the cell and maintains its shape. Cell walls are found in plant, fungi, and protist cells only.
Cell membrane	A cell membrane surrounds the entire cell. Its semipermeable structure helps move materials into and out of the cell.
Cytoplasm	As in prokaryotic cells, eukaryotic cells contain cytoplasm that takes up much of the space inside the cells.
Nucleus	The nucleus is the central organelle that holds DNA.
DNA	DNA within a eukaryotic cell is linear and organized into chromosomes. As with prokaryotic cells, DNA carries the instructions and genetic code for the cell.
Mitochondria	The mitochondria play major roles in transforming the energy in food into a usable form of energy called *ATP*. The cell then uses ATP to carry out activities such as reproduction and growth.
Endoplasmic reticulum (ER)	The endoplasmic reticulum, or ER, transports proteins and helps produce **lipids**.
Golgi apparatus	The Golgi body helps package and distribute proteins and lipids within the cell.
Ribosomes	Like prokaryotic cells, eukaryotic cells contain ribosomes that play roles in manufacturing proteins. However, the ribosomes in eukaryotic cells are larger and more complex.
Lysosomes	Lysosomes contain **enzymes** that help break down food or break down the cell when it dies.
Chloroplasts	Plant cells and some protists contain chloroplasts. These structures contain the green pigment chlorophyll, which captures the energy of sunlight for use in **photosynthesis**.
Central vacuole	Many plant cells contain a large central vacuole, which stores water, food, and waste. Animal cells contain vacuoles, but they are much smaller than the central vacuole found in plant cells.
Contractile vacuole	The contractile vacuole is a specialized vacuole, found in amoeba, that eliminates excess water from the cell. This adaptation assists in osmoregulation.
Cilia	Cilia are numerous, shorter (than flagella) projections located around the outside of a cell. By beating in near unison with a whiplike motion, cilia can move cells from one place to another or assist in transporting external substances.
Nuclear envelope	The nuclear envelope is the membrane that surrounds the genetic material and the nucleolus.
Nucleolus	The nucleolus is the structure inside the nucleus that hosts ribosome synthesis.

Eukaryotic Cell Structures (Continued)

Structure	Function
Chromatin	The chromatin forms the chromosomes inside the nucleus.
Chromosomes	Chromosomes are the structures made of wound DNA; they hold all of the genetic instructions for an organism.
Microtubules	Microtubules are the structures within eukaryotic cells that provide movement, including transportation.
Microfilaments	Microfilaments are thin proteins that make up the cytoskeleton.
Flagella	Flagella (singular: *flagellum*) are long, rotating filaments. A cell may have one flagellum, or it may have several flagella.

lipid – an organic compound that stores energy

enzyme – a protein in organisms that helps control a chemical reaction

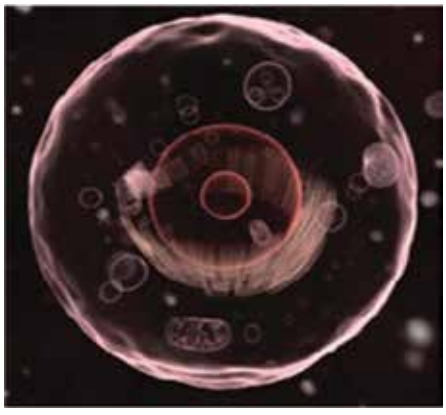
photosynthesis – the process by which certain organisms use the energy from the sun to make food

The Role of the Cell Membrane

The cell membrane serves as a highly selective barrier. *Active transport* is the movement of low-concentrated molecules through the cell membrane to an area of high concentration; the cell uses energy during this process. *Passive transport* is exactly the opposite; no cell energy is lost in this process, because passive transport works to maintain homeostasis.

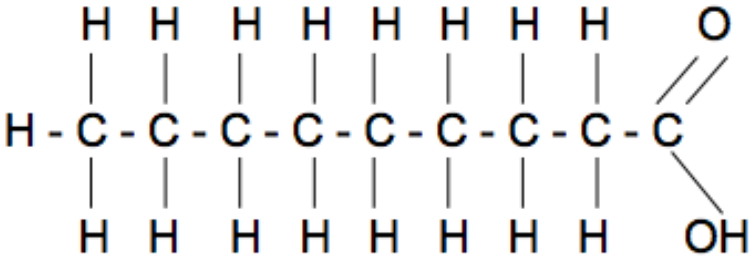
What Do You Think?

Take a look at the following images of cells. Which cell is prokaryotic, and which is eukaryotic? If the cell is prokaryotic, is it rodlike, spherical, or spiral?



The Origin of Eukaryotic Cells
Similar organelles exist between prokaryotic and eukaryotic cells—this is not coincidental. The evolutionary theory of *endosymbiosis* provides evidence as to how eukaryotic cells evolved from prokaryotic cells. The mitochondria and chloroplasts are regularly discussed because their genomes more resemble that of bacteria than anything else. Mitochondria also have their own cell membranes, just like prokaryotic cells do.

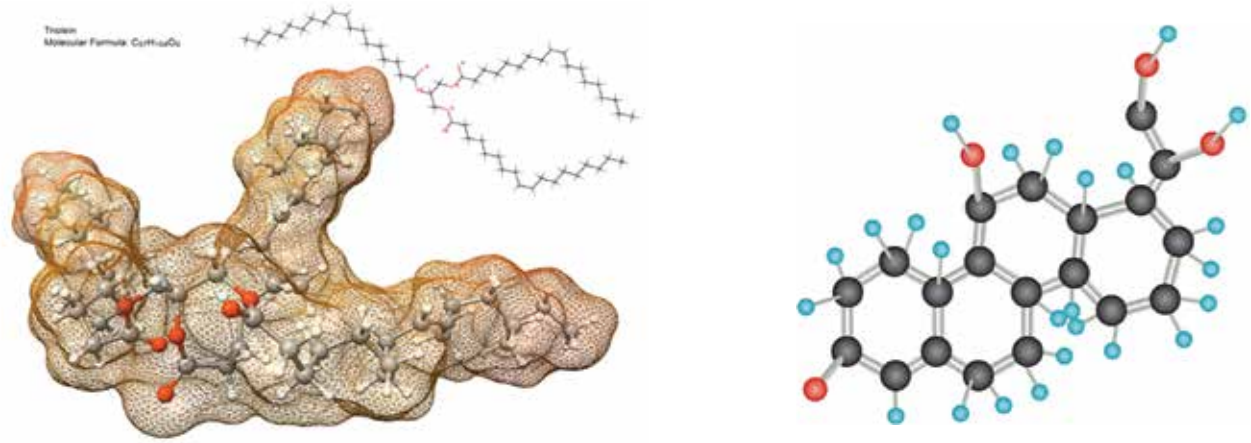
Fatty Acids, Triglycerides, Phospholipids, and Steroids
Fatty acids are made of long chains of hydrogen and oxygen with a carboxylic acid group on the end. The model below represents a fatty acid.



glycerol – a carbohydrate that consists of three carbons and links fatty acid chains

Triglycerides consist of three fatty acid chains that are linked by a **glycerol** molecule. Similarly, *phospholipids* consist of two fatty acid chains that are linked by a glycerol molecule and a phosphate group on the end.

Steroids are also made of carbon atoms. However, instead of being aligned in a chain, they consist of carbon rings.



Triglyceride model (left) and steroid model (right)

What Do You Think?

Fatty Acid Reactions

Fatty acids can undergo various reactions. The following are just a few.

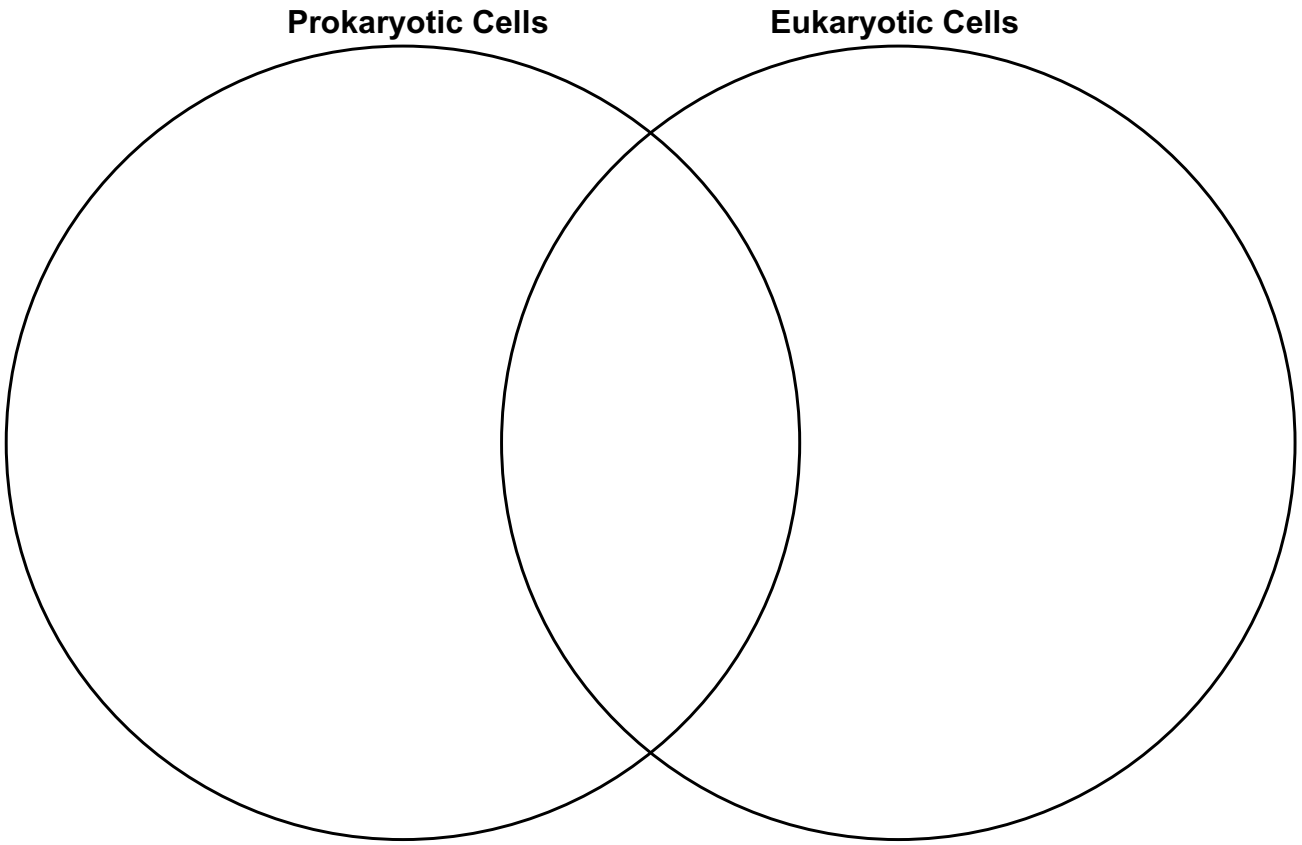
- *Hydrogenation and hardening* – Adding hydrogen atom pairs to unsaturated fatty acids; increases the melting point of the substance (e.g., transforming vegetable oil into margarine).
- *Auto-oxidation* – Oxidation that occurs when fatty acids are exposed to open air or oxygen; substances that contain antioxidants will not undergo this process.
- *Ozonolysis* – Some fatty acids are negatively impacted when introduced to ozone.

What Do You Know?

Compare prokaryotic cells and eukaryotic cells. Read the list of cell characteristics in the box below. Write each characteristic in the correct place on the Venn diagram.

Characteristics of Cells

• Contain a nucleus • Undergo metabolism • Contain DNA • Are usually smaller than 10 micrometers • Are found in fungi • May contain a cell wall • Reproduce	• Are bacteria and archaea • Contain membrane-bound organelles • Are found in all multicellular organisms • Contain chloroplasts



Connecting With Your Child

To help your child learn more about prokaryotic and eukaryotic cells, have him or her draw or create a three-dimensional model of each cell type. For eukaryotic cells, ask your child to choose either a plant cell or an animal cell. If your child is drawing the model, have him or her use colored pencils to sketch the cells and their structures. Your child should include labels and list the functions of each structure. If your child is creating a three-dimensional model, help him or her brainstorm ideas of materials to use, such as pipe cleaners, wax craft sticks, pom-poms, and string. Three-dimensional models should also include labels. Your child can use toothpicks, tape, and small pieces of paper to create numbered labels. Then he or she can create a written, numbered key on a sheet of paper. For example, a toothpick taped with the number 1 can be placed on the nucleus. The written key would indicate that the number 1 is a nucleus and is the centrally located organelle that contains DNA.

Discuss the following questions with your child:

- Which model was easier to create? Why do you think this is so?
- What are some types of prokaryotic cells that you could observe under a microscope? Do you think you would be able to see all of the structures? What about under a scanning or transmission electron microscope? Explain your answer.
- What are some types of eukaryotic cells that you could observe under a microscope? Do you think you would be able to see all of the structures? What about under a scanning or transmission electron microscope? Explain your answer.